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# Examining Elementary Teachers' Use of Digital Instructional Resources: A Cross-Cultural Study

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This research report examines teachers' purposes for working with digital resources in their mathematics instruction. We do so by undertaking an empirical, qualitative, cross-cultural analysis of interviews with 40 elementary school teachers from four educational contexts: Sweden, Finland, the US, and Belgium. We explore how teachers use digital resources for instructional and professional purposes and consider the possible opportunities for and challenges to transformation of teaching and learning. Despite wide variation in the types and quantity of digital resources used within and across contexts, we found some common purposes guiding teachers' selections and approaches. We also found that digital resources impacted multiple aspects of teachers' professional practices, including professional learning and interactions.

**Keywords:** Elementary Teachers, Elementary Mathematics, Digital Resources, Cross-cultural, Curriculum.

## PURPOSE

The first decade and a half of the 21<sup>st</sup> Century have seen a rapid proliferation of digital instructional resources (DIRs) available through publishers, online vendors, or open access initiatives. Many developers and educators see the potential for digital resources and tools to transform teachers' practices and students' learning opportunities, but research on teachers' interactions with them is scarce (Pepin, Choppin, Ruthven, Sinclair, 2017). Research on DIRs has primarily been concerned with student interactions (Pepin, Gueudet, & Trouche, 2013). In light of the articles that teachers play in choosing and using DIRs and the demands that these resources place on teachers, scholars have argued for research that focuses on teachers' perspectives and practices (Healy & Lagrange, 2010; Remillard, 2016).

In this research report, we focus on teachers' purposes for working with digital resources in their mathematics instruction. We draw on a qualitative analysis of interviews with 40 elementary school teachers from four educational contexts: Sweden, Finland, the U.S., and Belgium. The study falls under the conference Theme 2: Mathematics curriculum development and task design in the digital age.

The study takes a cross-cultural perspective. Previous analysis of the design of print curriculum resources from different educational contexts (Hemmi, Krzywacki, & Koljonen, 2017; Remillard, Van Steenbrugge, & Bergqvist, 2016) has surfaced different assumptions about learning and teaching mathematics and the type of support teachers need, despite the identified commonalities across official mathematics curriculum frameworks of these systems (Boesen et al., 2014). We believe that

studying teachers' use of DIRs contextually can shed light on the practices and norms within each context, and lead to wider understandings of how these resources can support the teaching and learning of mathematics. The following research questions guide our analysis:

- 1) How do teachers in different educational contexts describe the purposes and use of digital resources in their mathematics instruction?
- 2) To what extent do these purposes portend opportunities for transformation of teaching and learning through the take up of digital resources?

Our analysis assumes that teachers are key mediators in the uptake and use of curriculum resources, and, as such, the potential for these resources to transform mathematics teaching and learning is contingent on how teachers use them.

## BACKGROUND AND THEORETICAL FRAMING

Our research builds on existing frameworks for studying teachers' use of print curriculum resources (e.g., Gueudet & Trouche, 2009; Remillard, 2005) and a new framework oriented toward the design and affordances of digital curriculum resources (DCRs) (Pepin et al., 2017). Remillard (2005) conceptualizes teachers' curriculum use as a dynamic interplay between the teacher and the curriculum resource, viewing resource use as a participatory process, rather than one of passive implementation. In this process, teachers' beliefs, knowledge, and instructional purposes come into play as do features of the resource. There is empirical evidence that particular designs can support teacher learning through their use (Collopy, 2003; Stein & Kaufman, 2010).

Pepin et al. (2017) offer a framework for examining aspects of the designs of DCRs. They conceptualize features of DCRs and discuss their potential for having transformative impacts on teaching and learning. Given the adaptable nature of digital media, these features can create new opportunities for learning and for the work of teaching. The four features that impact the learning space include: a) the presentation space (how material and topics are presented to students); b) the problem space (types of problems students encounter and the range of ways they might solve them); c) the work space (tools and resources available to students to solve problems); and d) the navigational space (possible paths for progressing through the content of the resource including linear or nonlinear routes). Despite the potential for transformation across these various features, Pepin et al. argue that much of the current design activity in mathematics education focuses on the presentation space and suggest that transformation of learning through digital resource must include changes to the problem and work space, as well. Additionally, Pepin et al. discuss features that impact how teachers monitor and assess student learning, which can lead to shifts in teacher practices related to formative assessment and related instruction.

## DESIGN AND METHODS

The data come from the first of a four-year study of teachers' use of print and digital mathematics instructional resources in Belgium, Finland, Sweden, and the U.S. The

selection of educational contexts represents the cultural backgrounds of the research team and allows us to leverage insider perspectives in our analysis. In Belgium, we focus on the Flanders context, the Dutch-speaking community, which is culturally, and educationally distinct from Wallonia (the French-speaking community).

To identify participants, we selected two elementary mathematics curriculum programs from each context, one highly used and the other with unique characteristics. We identified a convenience sample of 10 grade 4 teachers, 5 from each program, from schools in each context, without the intent of giving a representative sample. They vary in years of experience and the type and size of school they teach in.

This paper presents findings from the first of two interviews of the 40 teachers. We conducted and audio recorded one, semistructured interviews, addressing teacher background and school characteristics; the print, digital, and concrete instructional resources used by the teacher; the teacher's views on these resources; the teacher's general beliefs about teaching and learning mathematics

Our analytical approach involved analysis based on conversations between insiders and outsiders of each context (c.f. Clarke, 2013; Hemmi & Ryve, 2015; Pepin & Haggarty, 2001; Stigler & Hiebert, 1999; Tobin, Hsueh, & Karasawa, 2009). Cultural insiders undertook initial coding, using a priori codes, in the original language of the interview, summarizing within context themes in a spreadsheet in English. The full team discussed selected themes and made comparisons across them. Through the discussions, several common purposes for choosing and using DIRs emerged. Cultural insiders then identified the purposes offered by all teachers in the interviews and summarized patterns in a matrix. The full team discussed similarities and differences provided clarifications, and used the four features identified Pepin et al. (2017) to consider the potential for transformation of learning opportunities through the uses of DIRs across the data set. When needed, team members translated illustrative quotes into English, which led to further discussion and clarification of the five purposes.

## FINDINGS

We identified three primary ways that teachers described using DIRs for mathematics instruction: a) enhancing whole-class instruction, b) structuring students' mathematics work, and c) professional participation and learning. Within these categories, teachers voiced different purposes for how they used DIRs. In this section, we outline commonly available digital tools and hardware in each context and then discuss the ways teachers used DIRs and the purposes behind their uses. We draw on Pepin et al. (2017) to consider the potential for transformation of learning spaces.

### Available Resources across Contexts

We found a range of different digital resources and tools in classrooms in four contexts. Almost all classrooms were equipped with interactive whiteboards and had access to computers or tablets on a regular basis. Several classrooms (in Sweden and U.S.) provided a laptop or tablet for each student throughout the day. All teachers had

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access to a range of resources available through the internet. In the three European contexts, teachers had access to online platforms, such as ViLE or Bingel, which allowed teachers to manage students' work on various assignments.

Enhancing Whole-Class Instruction

Participating teachers described two primary ways that they incorporated digital resources into their lessons: supplementing the presentation of their ~~based~~ curriculum programs and increasing opportunities for students to ~~inter~~share their work. These uses of digital resources fall within Pepin et al.'s (2017) category of presentation space. In all four contexts, teachers reported using interactive whiteboard or computer projectors to display static or dynamic portions of a print textbook, either as an image or with copied text.

Eight of 10 U.S. teachers reported using ready-made presentations or videos sources from the primary program or found online to present concepts to students. The criteria most often identified for selecting these resources were ease of use, likelihood of engaging students, and alignment with the content in the core program. A grade 6 teacher using Eureka Math described the videos she found to introduce concepts as:

They show visuals, they show ~~the~~É. This guy's kind of making it entertaining for them. The strategies are the tools that we're teaching; they both [the two video publishers] use kind of the same strategies and tools. Eureka (US8.EM6.Int1)

Only 1 of the 2 Swedish programs supplied digital presentations. Favorit Matematik and 4 of the 5 teachers using this program regularly employed them during instruction. Many of the Finnish teachers also reported projecting dynamic or static components of the textbook during instruction, although they did so with varying frequency. Only 3 of 10 Belgian teachers used dynamic or static components of the textbook during the instructional phase of their lessons, but all projected an image of the student textbook page during the practice phase of the lesson.

A number of Swedish teachers also described using tools, such as document camera or connected software, to incorporate student solutions into the lesson. This approach was particularly common among teachers trying the EPA instructional model, in which students first work on a task individually, then in pairs, and then discuss it with the whole class. As the following grade 5 teacher's explanation illustrates, teachers found digital tools valuable for integrating student work into whole-class discussion:

I post some [of the] results that we received during the lesson and then we discuss these solutions by asking, for instance: How did this person think it through? ... I photograph some of the results every time. They [the students] love this. They want to contribute with their solutions and to be posted on the board. SW8.MD5.Int1)

Across contexts, we observed a tendency for teachers to use DIRs to change digital instructional presentations to digital and often dynamic ones. This practice primarily impacted the presentation space (Pepin, et al., 2017), but in somewhat modest ways.

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some cases, through projecting student work, teachers found themselves engaging students differently in the presentation space of their lessons.

### Structuring Students' Mathematics Work

Across all four contexts, teachers viewed DIRs as providing opportunities for students to work, individually or with others during math class or for homework. This type of use of DIRs can affect both the problem space (types of problems and solution paths) and work space (tools available to solve them), as defined by Pepin et al. (2017). Teachers described three purposes for this type of resource use: engagement, personalization, and monitoring student progress.

**Making practice engaging.** Most of the Swedish teachers described using digital programs to provide students with additional practice in computation. Six of the teachers emphasized that these tools were either "fun" or offered a break from the usual routine. Others emphasized the importance of skill building, but they saw fun as a possible motivating factor or bonus. Similarly, all but one U.S. teacher said they assigned students to use game programs for several hours each week. Most of these programs focused on developing computational fluency through repeated practice. Teachers indicated that students found these computer games fun and engaging, and the adaptive features made the practice targeted and efficient.

Finnish and Belgian teachers provided more measured responses to this type of use of DIRs, questioning their role or added value over textbook tasks. In Belgium, several teachers said that they allowed students to use digital environments to solve problems at school or at home, but, they saw computer-based work as supplemental to paper-based tasks and physical tools, as exemplified by this grade 6 teacher:

The kids use that [DCR] instead of, when they have some time left or I don't know what. Instead of saying "Do [the usual additional exercises]," I think it's more interesting that they can do these [DCR] exercises. (FL4.KP6.Int1)

**Personalized learning** Many teachers saw DIRs as providing a way to personalize learning experiences based on their needs and abilities. Pepin et al. (2017) argue that DCRs can allow for flexible and varied problem spaces, affording opportunities for students to work on different types of problems and to proceed at their own pace. In the two contexts (Finland and U.S.) where curriculum programs provide substantive guidance on adapting learning opportunities, many teachers described deploying digital features provided by their primary programs or other sources to differentiate practice. Teachers in Finland described using a course design platform to tailor assignments to specific students. These assignments and tasks were adapted from the primary textbook. A Finnish teacher explained: "You don't need to indicate the same [tasks] for everyone as there are plenty of them." (FI4.TT3.Int1). The 9 U.S. teachers who used DIRs had their students use game platforms that either automatically adapted to students' abilities by providing hints, explanations, and videos, or which they could use to assign different tasks based on students' needs.

Use of DIRs for personalized learning was mentioned less frequently as a purpose by teachers from Belgium and Sweden, the two contexts where curriculum programs provide substantially less teacher guidance on adapting learning opportunities. For instance, only one Belgian teacher described differentiating instruction with the help of the platform Bingel, doing so based on student test scores.

**Assessing and Monitoring** According to Pepin et al. (2017), DCRs have the potential to deepen and extend the role of formative assessment in mathematics instruction. We found that teachers used digital resources to enhance their approaches to assessing and monitoring student work in two ways: tailoring assessments to students and monitoring student progress through system-generated tracking and reports. Teachers in Finland and Sweden described using digital platforms, such as ViLLE or Bingel, to monitor student progress on individualized assignments. One Finnish teacher explained: "It's easy for a teacher to monitor and download new assignments weekly and then check who had completed them all" (FI1.TT3.Int1). The majority of U.S. teachers also indicated that they used data reports from game-based environments to monitor students' progress on assignments. In addition, several Finnish teachers used assessment problem banks to design tests, though they gave students printed versions.

When teachers spoke of using DIRs to assign students engaging or personalized tasks, the tasks typically involved computational practice, rather than other types of problem solving. In other words, although students are working in digital environments, they may not be encountering different types of problems than standard drill and practice.

### Professional Participation and Learning

In addition to using DIRs to support their mathematics instruction, teachers in three of the contexts described enhancing their professional practice through online collaboration with other teachers, communicating with parents digitally, or engaging in online professional learning. Although these noninstructional aspects of teachers' work are infrequently discussed as affordances of DCRs, we believe they may underlie important instructional transformations.

File sharing with colleagues through online repositories was the most prominent way that teachers used digital resources to enhance their practice. All 10 U.S. teachers shared lesson plans, assessments, and other activities through game-based platforms maintained by teachers, schools, or districts. One Belgian teacher reported using Dropbox to share lessons and other resources with her grade colleague. U.S. and Swedish teachers also described using teacher websites to share lesson plans and files those developed by other teachers. This type of online collaboration was not mentioned by Finnish teachers. Because this particular purpose was emergent in our data, we did not ask about it explicitly in our interviews; it is possible that some teachers who shared lesson materials online did not report it.

One other professional purpose emerged primarily from the U.S. teacher interviews. Four teachers reported watching videos designed to educate teachers about the mathematics concepts and lesson progressions in the units they were teaching. Some

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! videos were provided by the curriculum publishers, while others were found on YouTube. One Belgian teacher also reported changing her instructional approach for a lesson after viewing a YouTube video recommended by a colleague.

## DISCUSSION AND SIGNIFICANCE

The preliminary findings discussed above suggest a wide range of DIRs being used by teachers across the four contexts and a set of common purposes behind their use. With these purposes, however, we found substantial variation across, and sometimes within contexts. In line with an observation made by Pepin et al. (2017), we found that the learning space most impacted by digital resources appears to be the presentation space. We also see DIRs impacting the problem space, but the types of problems students encounter remains mainly unchanged from those encountered in print textbooks. We found almost no impact on the work or navigational spaces. While participating teachers were selected due to their use of programs that have both print and digital components, the narrow impact of DIRs is worth noting and merits further exploration. On the other hand, the unanticipated theme of professional participation and learning offers a different place to look for the impact of digital tools on elementary teachers' work. We might understand these forms of professional collaboration and learning as one way that DIRs can support teachers to transform their practice.

## NOTE

1. We use the term digital instructional resources (DIRs) to refer to all resources designed and appropriated to support instruction. The term digital curriculum resource (DCR) has been used to refer to such resources that are curricular in nature, in that they contain a scope and sequence and are designed to support instruction over time. DIR is a more general term. See Pepin et al. (2017) and Remillard (2016) for more on this distinction.

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